LONDON AND LEEDS BLOOD LEAD STUDIES: Update

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Grant Holders: W. Yule (Institute of Psychiatry)
R. Lansdown (Hospital for Sick Children)

Research Officers: M. Urbanowicz
J. Hunter

Chemical Pathology: B. Clayton (South Hampton)
T. Delves (South Hampton)

It is difficult to obtain venepuncture blood samples from children for research purposes in the UK. We therefore took advantage of the EEC surveys and looked at 2 samples of children whose blood leads were ascertained as part of those studies, together with one sample of children whose parents had organized blood sampling locally.

First London Study

The primary purpose was to apply the Needleman et al (1979) behavior rating scale to an English sample. Measures of intelligence (WISC-R), academic attainment, and other behavior rating scales (Conners and Rutter) were also obtained. The only information obtained on social factors was fathers occupation.

The results have been presented in three papers (Yule et al., 1981, 1984; Lansdown et al., 1983). Blood leads were related to social class. Even after social class and age were controlled for, significant differences between lead groups remained at measures of reading, spelling and intelligence. It must be stressed that the blood lead levels ranged from 7 to 32 ug/dl with a mean of 13.52 ug/dl (SD = 4.13).

With regard to behavior ratings, our findings broadly replicate the earlier Boston findings as seen in Figure 1. The findings on the Conner's Scale (Table

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1) and the Ruttes Scale (Table 2) show that lead level is significantly related to Conduct Problems, Aggression and Inattention but not to "emotional" disorders. In none of these analyses were IQ or SES controlled.

Second London Study

Parents of children living near an urban motorway had been concerned about the possible effects of airborne lead on their children. We studied 194 children aged 6 to 12 years. In addition to the psychometric battery and behavior rating scales as used in the first study, we used a 2 hour structured interview, bared closely on the one developed by Marjorie Smith, Great Ormond Street, to investigate the children's exposure to lead as well as social and emotional factors in the family which might relate to intelligence and adjustment. We obtained short WAIS-R IQs on 94% of mothers and 79% of fathers. As the blood leads had been taken 20 months prior to our psychological data, we tried to get a second sample from all children. We obtained 162 second samples, but, for reasons that have not been adequately discovered, the validity of the second samples is in doubt - and so the analyses were performed in relation to the earlier PbB samples.

It soon became apparent that this was a very homogenous social group - in our Registors General's classification of occupations, 54% were in social class I, II and III (non-manual) - a predominatly middle class group. PbB was not related to social class. The range of PbB was 7 to 24 ug/dl with an average of 12.8 ug/dl (SD = 3.07).

The children were reported by parents and teachers to have very few behavioral problems. In essence, the findings with respect to lead effects on both

cognition and behavior were essentially negative. Table 3 shows the relationship between PbB and IQ separately for the middle-class and manual groups. Although within the manual group there is a 5 point difference in full scale IQ between the lowest (7-10 ug/dl) and highest (15-24 ug/dl) lead groups, this difference is not statistically significant. Table 4 shows the results of the unforced stepwise regression analyses performed on 162 sets of data from children who gave two blood samples. In no case does PbB emerge as a significant variable.

Given these findings, we have not-proceeded further with the analyses of the data with respect to PbB, although we will analyse the data from the interview with respect to sources.

Leeds Study

Taking advantage of the second round of EEC surveys, we applied our test battery to 302 children aged 6 to 12 years in Leeds. Some of these children are children of lead workers; some live near a lead smelter; and two sub-groups live in the inner city - one group in predominatly pre-1914 housing; one group in predominantly post-1945 housing. The housing age is related to paint lead level and the children's PbB differ by an average of 2 ug/dl. To our battery, we added computerized versions of the delayed reaction time test used in the Boston Study, and a finger tapping test.

The Leeds sample is from predominantly skilled manual homes. The PbB ranges from 5 to 26 ug/dl (mean = 11.85 ug/dl). The preliminary analyses of the IQ data are seen in Table 5 where it is obvious that even before controlling for social factors;, there is little relationship between PbB and IQ.

The behavior rating results are similar to those found in our first, pilot study and the data from the Conner's scale are given in Table 6.

In all three samples, we have found that children who are reported to suck their thumbs or bite their nails are found to have higher PbB.

** Figure 2 and 3 sumarize our data on the reaction time study. In this, we used a small home computer to present the tones after 3 or 12 seconds delay. Children were asked to place a finger on one button on the signal "Ready" and to press the other button when the tone sounded. As can be seen, performance on the task is strongly age related. RT was not related to IQ. The finging's of one High lead (14-26 ug/dl) and low lead (5-8 ug/dl) groups, corrected for age, are shown in Figure 3, along with the earlier published studies from the Boston group. As yet, we have not controlled for social factors in these analyses.

Preliminary Conclusions

The neuropsychological effects of lead, within the range seen today in most ordinary British environments without special high risks, are quite small. In relation to measured intelligence, lead is unlikely to account for more than 2 to 3% of the variance, less than that associated with other genetic and environmental factors. Even so, it is recognized that a 2 to 5 IQ point difference between relatively high and very low lead levels does have considerable social policy implications.

It is very difficult to infer causality from epidemiological studies such as are presented here. There are still conceptual and statisitcal arguments about how best to control for confounding social factors. There is some indication that, as with perinatal morbidity, effects may be stronger among socially disadvantaged groups.

The behavior rating and neuropsychological studies indicate that "attention" and activity level may be affected by lead, but the influence of social and emotional factors on these relationships has still to be determined. Futher cross-sectional studies are unlikely to take this much further until we have better, more sensitive and more valid measures of neuropsychological functioning.

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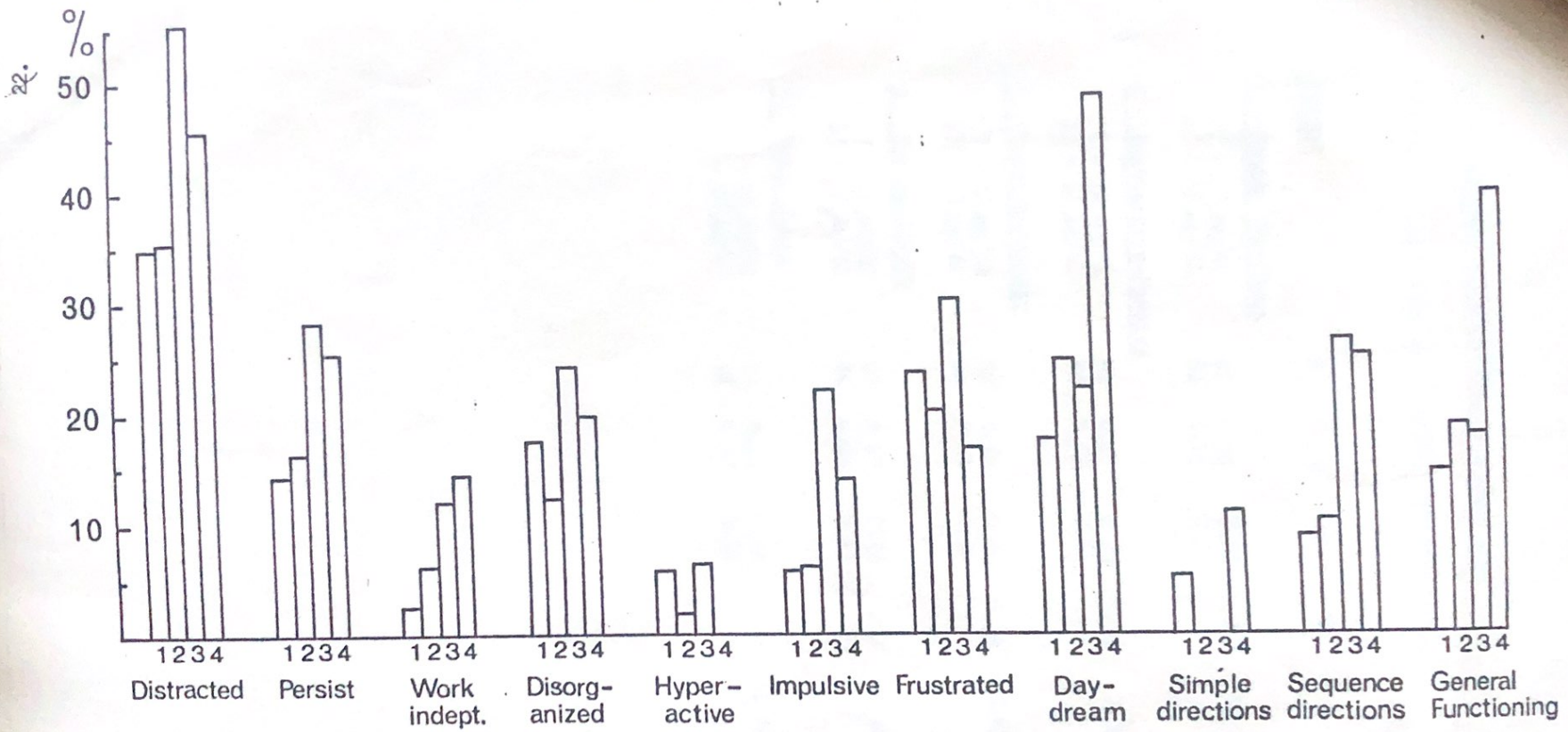
PERCENTAGE OF NEGATIVE RATINGS ON NEEDLEMAN SCALES BY LEAD LEVELS

Pilot lead study – 166 children aged 6 – 12 years



LEAD LEVELS

1 7 – 10 µg/dl
2 11 – 12 "
3 13 – 16 "
4 17 – 32 "

Table 1

LEAD LEVEL AND CONNER'S FACTOR SCORES -

SUMMARIES OF ANALYSES OF VARIANCE AND COVARIANCE

FACTOR	N	Mean	SD	F	P	Controlling for A: F'	P
1. Conduct Problems							
7 - 12 µg/dl	82	0.04	0.26	4.21	0.04	4.02	0.05
13 - 32 µg/dl	84	0.15	0.40				
2. Inattentive-Passive							
7 - 12 µg/dl	82	0.41	0.56	5.16	0.02	5.68	0.02
13 - 32 µg/dl	84	0.62	0.64				
3. Tension-Anxiety							
7 - 12 µg/dl	82	0.38	0.34	0.18	0.67	0.52	0.47
13 - 32 µg/dl	84	0.41	0.46				
4. Hyperactivity							
7 - 12 µg/dl	82	0.27	0.41	4.50	0.04	5.88	0.02
13 - 32 µg/dl	84	0.44	0.61				
5. Total Score							
7 - 12 µg/dl	82	0.26	0.28	4.22	0.04	4.97	0.03
13 - 32 µg/dl	84	0.37	0.39				

TABLE 2

B(2) OVERACTIVITY SCALE AND BLOOD LEAD LEVELS

a) Analysis of Variance

PB Group	OVERACTIVITY SCORE MEAN	S.D.	F	P
7 – 11	0.68	1.32	2.15	0.096
11 – 12	0.58	0.94		
13 – 16	1.27	1.83		
17 – 32	0.91	1.38		

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b) Chi^2 analysis – Children categorised as "overactive" if score on 3 items is 3 or over.

PB Group	OVERACTIVITY SCORE 0 – 2	3 – 6
7 – 11	32(94.1%)	2 (5.9%)
11 – 12	46(95.8%)	2 (4.2%)
13 – 16	39(79.6%)	10(20.4%)
17 – 32	29(82.9%)	6 (17.1%)

$Chi^2 = 8.12$, 3df, P = 0.04

	0 – 2	3 – 6	
12	78	4 (4.1%)	82
13	68	16 (19.0%)	84
			166

TABLE 3

Analyses of variance dividing sample into manual and non-manual Soc. Cl. Using approx. quartiles of Pb distribution.

		Non-manual Group					Manual Group				
Dep. Var.	Pb grp	N	Mean	SD	F	Prob	N	Mean	S.D.	F	Prob
AGE	I	28	113.54	22.20	2.37	0.07	16	123.87	23.98	5.71	0.0013
	II	26	102.77	26.06			25	112.24	22.14		
	III	27	114.81	25.16			21	117.19	27.96		
	IV	21	98.95	28.01			25	95.88	18.95		
Dep. var	Pb grp	N	Mean	SD	F	Fprob	N	Mean	SD	F	FProb
VERBAL IQ	I	28	102.29	16.57	1.93	0.13	I 16	102.31	12.54	0.31	0.82
	II	26	109.88	14.55			II 25	98.32	9.30		
	III	27	103.67	14.39			III 21	98.95	14.74		
	IV	21	110.52	15.25			IV 25	99.48	16.09		
PERFORMANCE IQ	I	28	104.07	13.13	1.85		I 16	110.19	13.59	1.04	0.38
	II	26	110.61	15.99	P=0.14		II 25	103.64	14.65		
	III	27	106.33	15.18			III 21	103.48	10.97		
	IV	21	112.29	9.65			IV 25	103.40	14.63		
FULL SCALE IQ	I	28	103.39	13.52	2.52		I 16	106.87	12.98	0.83	0.48
	II	26	111.42	14.94	P=0.06		II 25	100.68	11.48		
	III	27	105.33	15.03			III 21	101.09	13.16		
	IV	21	112.52	12.81			IV 25	101.32	15.73		

Lead Groupings: I = 7-10 µg/100ml

II = 11-12 µg/100 ml

III = 13-14 µg/100 ml

IV = 15-24 µg/100 ml

TABLE 4

SUMMARY UNFORCED STEPWISE REGRESSION ANALYSES — FIRST BLOOD LEAD (Log PbB-1)

CRITERION	ORDER	REG^{N}. COEFFT.	SE	F	P
ACCURACY OF READING	1. AGE	0.66	0.05	165.76	0.000
	2. Log PbB-1	-9.69	5.48	3.13	0.08
	3. SOC. CLASS	-1.37	0.87	2.46	0.12
	CONSTANT	72.17			
COMPREHENSION OF READING	1. AGE	0.68	0.05	159.68	0.000
	2. SOC. CLASS	-2.23	0.92	5.85	0.01
	3. Log PbB-1	-6.58	5.75	1.31	0.25
	CONSTANT	61.48			
SPELLING	1. SOC. CLASS	-1.22	0.77	2.48	0.12
	2. Log PbB-1	-4.30	4.65	0.85	0.36
	3. AGE	-0.14	0.05	0.09	0.76
	CONSTANT	117.15			
MATHEMATICS	1. AGE	0.11	0.05	4.98	0.03
	2. Log PbB-1	-4.32	5.55	0.61	0.44
	3. SOC. CLASS	-0.22	0.89	0.06	0.81
	CONSTANT	99.73			
VERBAL IQ	1. SOC. CLASS	-2.69	0.78	11.82	0.001
	2. AGE	-0.11	0.04	6.58	0.01
	CONSTANT	124.95			
PERFORMANCE IQ	1. SOC. CLASS	-1.58	0.73	4.63	0.03
	2. Log PbB-1	-2.25	4.41	0.26	0.61
	3. AGE	-0.18	0.44	0.15	0.69
	CONSTANT	121.36			
FULL SCALE IQ	1. SOC. CLASS	-2.43	0.75	10.47	0.001
	2. AGE	-0.71	0.04	2.70	0.10
	3. Log PbB-1	-1.64	4.69	0.12	0.73
	CONSTANT	126.19			

TABLE 5

Table Two Analyses of data on blood lead studies

First London Study: Analysis of covariance, social class partialled out

Lead Group	Adjusted means: Reading Accuracy	Reading Comprehension	WISC-R Verbal	WISC-R Performance	WISC-R Full Scale
7-10µg/dl	121	117	101.48	105.09	103.32
11-12 "	110	110	101.48	103.43	102.68
13-16 "	98	95	94.69	97.90	95.75
17-32 "	89	88	93.93	98.80	95.70
Social Class	ns	0.095	0.009	ns	0.029
Lead	0.001	0.001	0.043	0.102	0.027

Second London Study: Analysis of covariance, social class partialled out

Lead Group	Adjusted means: Reading Accuracy	Reading Comprehension	WISC-R Verbal	WISC-R Performance	WISC-R Full Scale
7-12µg/dl	114	113	104.48	108.20	106.86
13-24 "	111	109	103.43	106.32	105.18
Social Class	ns	0.02	0.001	0.04	0.001
Lead	ns	ns	ns	ns	ns

Leeds Study by social class group

Lead Group	Verbal IQ Non Manual	Verbal IQ Manual	Performance IQ Non Manual	Performance IQ Manual	Full Scale IQ Non Manual	Full Scale IQ Manual
5-11µg/dl	107.03	98.56	111.57	103.50	110.03	100.79
12-26 "	110.09	97.18	112.63	103.23	112.45	99.75

Table 6

LEEDS SAMPLE

One-way Analyses of Variance

Lead quartiles X Connors factors (Teacher Scale)

1. CONDUCT

Lead Group		N	Mean	S.D.	F	P
1	(5-8 ug/dl)	56	0.10	0.32	4.87	0.003*
2	(9,10 ug/dl)	58	0.16	0.29		
3	(11-13 ug/dl)	86	0.19	0.37		
4	(14-26 ug/dl)	81	0.34	0.47		

2. HYPERACTIVE

Lead Group	N	Mean	S.D.	F	P
1	56	0.34	0.55	3.18	0.02*
2	58	0.32	0.40		
3	87	0.46	0.63		
4	81	0.60	0.67		

3. TENSION

Lead Group	N	Mean	S.D.	F	P
1	56	0.46	0.51	0.24	0.87 NS
2	58	0.41	0.41		
3	87	0.41	0.47		
4	81	0.39	0.45		

4. INATTENTIVE/PASSIVE

Lead Group	N	Mean	S.D.	F	P
1	56	0.42	0.50	4.04	0.008*
2	58	0.59	0.60		
3	87	0.56	0.63		
4	81	0.80	0.77		

Fig 3

Mean Reaction Time by Trial Block for two extreme lead quartiles (adjusted for log age)

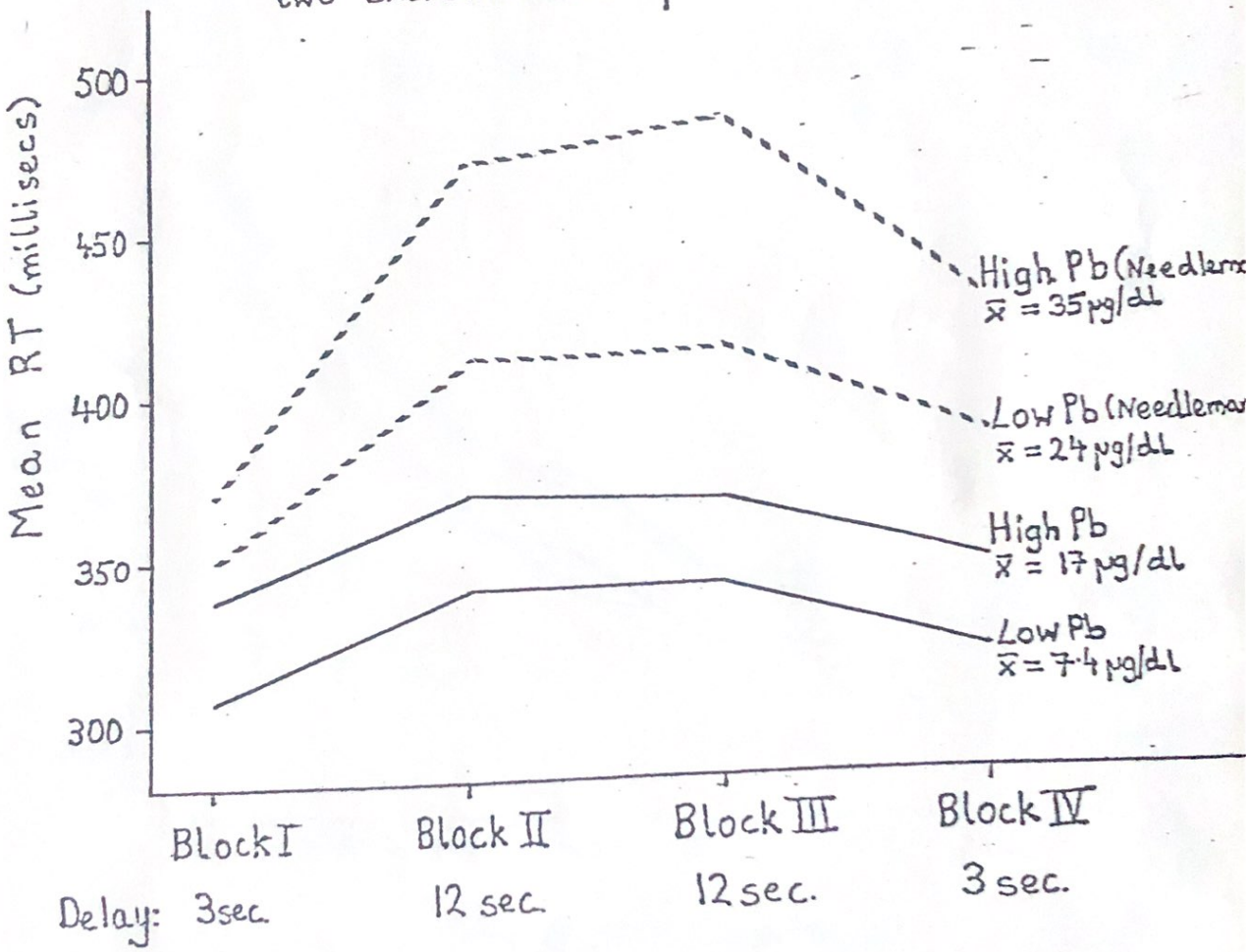
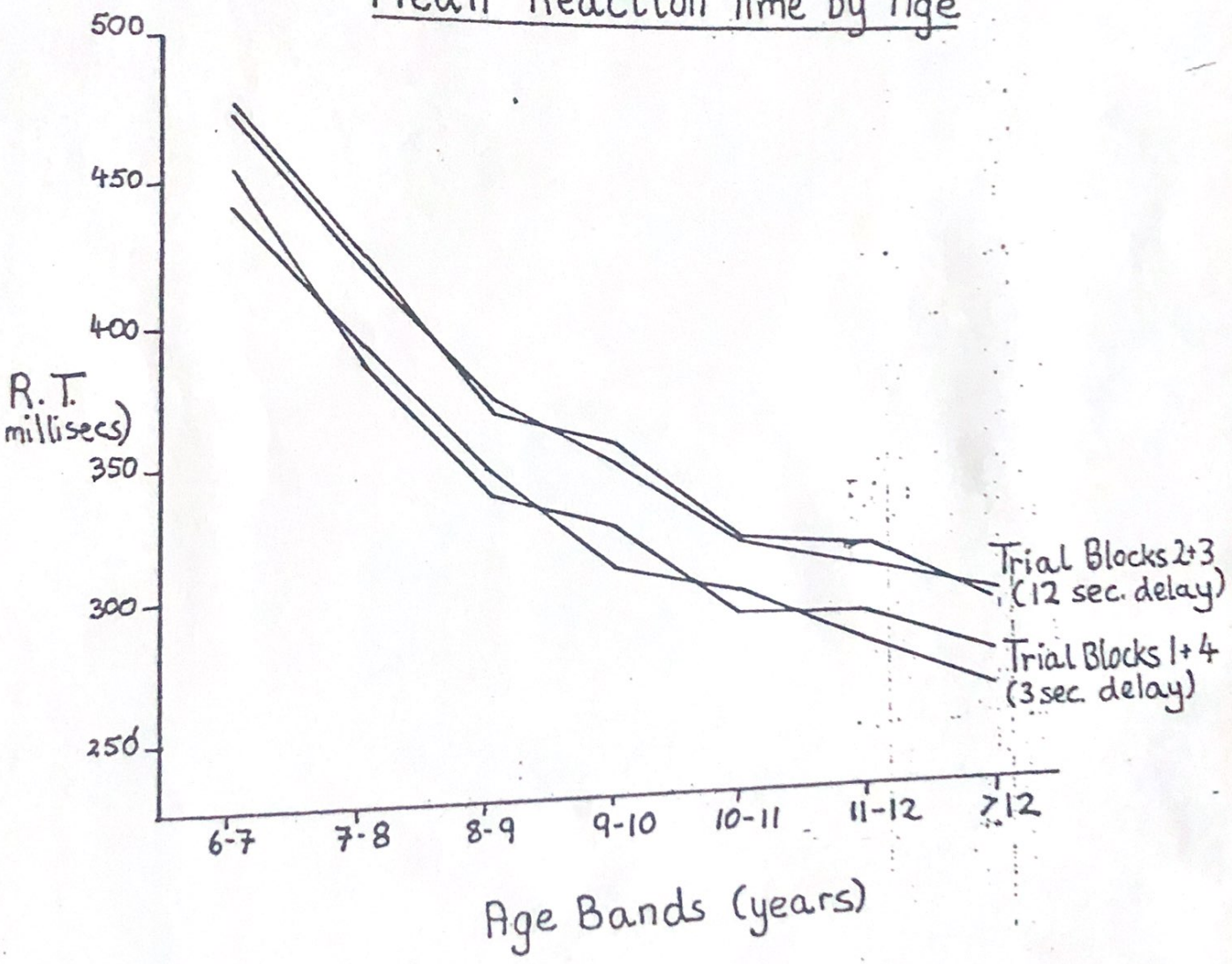


Fig 1


Mean Reaction Time by Age
500
450
400
R.T. millisecs)
350
300
250
6-7
7-8
8-9
9-10
10-11
11-12
>12
Age Bands (years)
Trial Blocks 2+3 (12 sec. delay)
Trial Blocks 1+4 (3 sec. delay)